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ABSTRACT

The course of study represents the second of six modules in advanced crop and soil science and introduces the agriculture student to the subject of physical features of the soil. Upon completing the two day lesson, the student will be able to determine the texture and structural types of soil, list the structural classes of the soil and where they are found in the profile, discuss the influence soil texture and structure have on the physical features of the soil, and calculate bulk and particle density. The course outline suggests teaching procedures, behavioral objectives, teaching aids and references, problems, summary, and evaluation. Following the lesson plans, pages are coded for use as handouts and overhead transparencies. A materials source list for the complete soil module is included. (MW)

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PHYSICAL FEATURES OF SOIL

Agricultural Education, College of Education
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

In Cooperation With

Agricultural Education Service, Division of Vocational Education
State Department of Education, Richmond, VA 23216
Prepared by Larry E. Miller

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1974

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ADVANCED CROP AND SOIL SCIENCE
A COURSE OF STUDY

Prepared by
Larry E. Miller

Agricultural Education Program
Division of Vocational and Technical Education
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A Virginia Polytechnic Institute and State University
Extension Division
Education Field Service Publication

How to Use This Book

This course of study is divided into six modules, as enumerated in the index. Each lesson plan contains the title of the:

course,
module,
a suggested time allotment,
a suggested teaching procedure,
objectives of the lesson,
example introduction techniques,
suggested references and teaching aids,
problems,
summary.
and example evaluatory statements.

Space is provided for individual evaluation.

Modules are lettered consecutively, with numbered pages within each module. A small letter following the number denotes its position within the numbered sequence. Following the lesson plans, pages are also denoted with the letter "H", recommended as a handout; and the letter "T", recommended as an overhead transparency.

Some instructors may find it of greater convenience to assemble a "slide-bank" of these teaching aids.

Materials Source List
(Soil Module Only)

SELECTED REFERENCES:

Books:

*Profitable Soil Management, Knuti, Korpi and Hide, Prentice-Hall, Englewood Cliffs, New Jersey 07632, 1969, $8.36.
*Introductory Soils, Berger, K.C., 1965, Macmillan Company, 866 3rd. Avenue, New York, N.Y. 10022, $8.50.
*Soils: An Introduction to Soils and Plant Growth, 2nd Ed., Donahue, Prentice-Hall, 1964, $9.75.
*Approved Practices in Soil Conservation, Foster, Interstate, 1964, $3.80.
*Our Soils and Their Management, Donahue, Interstate, $5.00.
**Farm Soils, Worthen and Aldrich, Wiley & Sons.
**Fundamentals of Soil Science, Millar, Turk.
**The Nature and Properties of Soils, Buckman and Brady, Macmillan, 1969, $10.95.
**Soils and Soil Fertility, Thompson, McGraw-Hill.
**Soil Fertility and Fertilizers, Tisdale and Nelson, Macmillan, 2nd Ed. 1966, $12.95.
**Soil Use and Improvement, Stallings, J.H., Prentice-Hall, $8.36.
**Soil Management for Conservation and Production, Cook, J.W. Wiley and Sons, 1962.
**Soil Physics, Kohnke, McGraw-Hill.
**Using Commercial Fertilizers, McVicker, Interstate, 1961, $4.00 Good.
**Our Natural Resources, McNall, Interstate, 1964.
**Soil Science Simplified, Kohnke & Helmut, Bolt, 1962. Good.
**Soil Conservation, Stallings, Prentice-Hall, 1957, $11.75.
*Experiments in Soil Science, California State Polytechnic College, San Luis Obispo, California 93401, $4.00.
**Factors of Soil Formation, Jenny.

Bulletins:

*"Soil Judging in Indiana" Purdue Mimeo I.D. 72.
*"Soil Color" Voc. Ag. Service, 434 Mumford Hall, Urbana, Illinois 61801
*"Soil Texture" - Illinois V.A.S.
**"Teaching Soil and Water Conservation, A Classroom and Field Guide" PA 341 U.S.D.A.
**"Water Intake by Soil Experiements for High School Students" Misc. Publ. No. 925, U.S.D.A.
**Soils Yearbook, U.S.D.A.
**Land Capability Classification, Agriculture Handbook No. 210, U.S.D.A.
**Soil Survey Manual, U.S.D.A."
*"Sampling the Soil", National Fertilizer Association, Washington, D.C.
*"Soil Testing" Purdue University Extension Circular, 488.
**"The Fertilizer Handbook:, National Plant Food Institute (NPFI) 1700 K. Street N.W., Washington, D.C. 20006

*Student Reference
**Instructor or Classroom reference

*"Our Land and Its Care", N. P. F. I.
*"What is Fertilizer?" N. P. F. I.
*"How to Take a Soil Sample", N. P. F. I. (Leaflets** and Poster*)
*"Lime Means More Money for You", N. P. F. I. (leaflets** and Poster*)
**"How Soil pH Affects Plant Food Availability", N. P. F. I. (Poster)
**"Hunger Signs in Crops", Illinois V. A. S., VAS 4011a
*"Soil and Plant Tissue Tests", Purdue Station Bulletin 635
*"Soil Science Simplified", Kohnke, Published by Author

Films:

"The Depth of Our Roots", New Holland, C-18 Min.
"Making the Most of a Miracle" (Plant Nutrition), N. P. F. I.
"The Big Test" (Importance of Soil Testing), N. P. F. I.
"What's in the Bag" (Fertilizer) N. P. F. I.

Film Bulletin:

"Films to Tell the Soil and Water Conservation Story" 1970 Soil Conservation Service, Film Library, Rm. 503-134 So. 12th St., Lincoln, Nebraska 68508.

Film Strips:

"Soil Color" Vo-Ag. Service, 434 Mumford Hall, Urbana, Illinois.
"Soil Structure" Vo-Ag. Service, Illinois.
"How and Why Soils Differ", Vo-Ag. Service, Illinois.

Slides:

"How to Take a Soil Sample", N. P. F. I.
"Soils, Plant Nutrition and Fertilizers", N. P. F. I.
"Deficiency Symptoms" (Choice by crop, 25¢ ea.) N. P. F. I. (Send for Catalog.)
"Soil Profile Slides", 16 slides, $6.00. (Send for Catalog.)

Periodicals:

"Plant Food Review", N. P. F. I. (Free to Schools.)

TEACHER'S CURRICULUM GUIDES FOR SOILS

"Understanding the Nature and Importance of Soil", AP-1, C. E. Richard, VPI & SU, Blacksburg.

"Preparing the Soil for Planting", AP-3, C. E. Richard, VPI & SU, Blacksburg.

"Developing a Soil and Water Conservation Plan", AP-4, C. E. Richard, VPI & SU, Blacksburg.

"Testing Soils", AP-8, C. E. Richard, VPI & SU, Blacksburg.

"Determining Land Capability Classes", AP-2, C. E. Richard, VPI & SU, Blacksburg.

Extension Division Bulletins, VPI & SU,
Blacksburg, Virginia 24061.

NO.	PUBLICATION
342	"No-tillage Corn - Current Virginia Recommendations"
429	"Soil Fertility Guides for the Piedmont"
97	"Agronomy Handbook"
136	"How Soil Reaction Affects the Supply of Plant Nutrients"
297	"Soil Fertility Guides - for the Coastal Plains Region of Virginia"
299	"Soil Fertility Guides - for the Appalachian Region of Virginia"
684	"Liming for Efficient Crop Production"
36	"Your Fertilizer Use and Crop Record"
106	"Lime Use Guides - for the Coastal Plains Region of Virginia"
107	"Lime Use Guides - for the Appalachian Region of Virginia"
108	"Lime Use Guides - for the Piedmont Region of Virginia"
405	"Lime for Acid Soils"
34	"Soil and Water Conservation Record Book"
CS48	"Soil Sterilization"
47	"Know Your Soils, Unit 2, Major Soil Differences"
23	"The Story of Land"
228	"Working Together for a Liveable Land"

USDA Bulletins (1 each of 100 publications, free)
Publications Division, Office of Information,
U.S.D.A., Washington, D.C. 20250. *FOR SALE ONLY

NO.	PUBLICATION	PRICE
AH210	Land Capability Classification. 1961	.15¢
AH18	Soil Survey Manual. 1951.	$3.50*
AB320	Know the Soil You Build On. 1967.	--
L539	Land Forming, A Means of Controlling Surface Water on Level Fields. 1967	.05*
L512	Mulch Tillage in the Southeast	--
YB1957	Soil (Yearbook)	$4.00*
L307	How Much Fertilizer Shall I Use? 1963.	--
G89	Selecting Fertilizers for Lawns and Gardens. 1971.	--
TITLE	Superphosphate: Its History, Chemistry, and Manufacture. 1964.	$3.25*

*"Maintaining Organic Matter in Soils" VAS, Illinois
*"Soil Structure" VAS, Illinois

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*Student Reference
**Instructor or Classroom Reference

TEACHING AIDS:

1. Samples of Soil separates, Purdue Agronomy Club
   Life Science Building
   Purdue University
   Lafayette, Indiana 47907

2. Soil Profiles
   Information and directions necessary to make soil profiles.

3. Land Capability Maps - Local S.C.S. Office.

4. Soil Auger: Nasco, price range $4.79 - $13.50.

5. Tissue Test Kit V.A.S. $4.00/kit.

6. Transparencies.

7. Samples of soil structure.

PREPARING FOR SOILS MODULE

Proper preparation, as in all things, is one of the best assurances of success. Therefore, it is imperative that prior planning be completed before teaching each lesson.

Plans should be made several weeks or months preceding the need for much of the material. Films should be booked as soon as possible to assure their arrival when needed. This will necessitate careful thought in the preparation of your teaching calendar for this module. An inventory of present equipment should yield information necessary to securing needed teaching aids, equipment, and replenishing supplies.

Many other teaching aids can be compiled on shorter notice. Handouts and overhead transparencies can be supplied on rather short notice in most schools. Adjustments will be necessary according to the instructor's and school's clerical assistance in this area.

Short range planning varies considerably with individual instructor's competencies in the teaching area and with previous teaching experience One may generalize, however, and conclude from good teaching methods, that films should be previewed; experiments and demonstrations "pre-run". Subject matter should be reviewed, and adapted and updated lesson plans will be of benefit for each lesson.

The author has attempted to exclude materials that were presumably taught in previous vo-ag. offerings. It will be necessary for each instructor to discern if a review of previous material is necessary. The author has attempted to provide several teaching techniques for each lesson. It is not assumed that all would be used within the time allotment, but that you may have as many alternatives as possible from which to select.

Soil Module Time Allotment
Allotted days: 15 (at 55 minutes period per day)

Lesson		Minutes
I:	What is soil?	110
II:	Physical Features of Soil	110
III:	Biological Features of Soil	110
IV:	Soil Water	165
V:	Chemical Features of Soil	220
VI:	Soil Erosion	110
	TOTAL (15-55 min. days)	825

Course: Advanced Crop and Soil Science

Module: Soils

Lesson II: Physical Features of Soil

Suggested teaching time: 2 days

Suggested teaching procedure:

1. Introduce lesson by relating objectives and motivational statements and other teaching aids.

2. Make assignment and supervise study period.

3. Discuss results using teaching aids:

   a) Show the transparencies "Soil Texture", "Relative Sizes of Sand, Silt, and Clay", "Sizes of Soil Separates", and "Soil Textural Classification Triangle" and discuss. Show filmstrip "Soil Texture" and use bulletin "Soil Texture" to supplement discussion. Use either, or both, of the demonstrations to illustrate how texture is determined. Discuss determination using handout on "feel method."
   b) Show transparency "Soil Structure" and discuss using bulletins "Soil Color" and "Soil Structure" and filmstrips of the same name.
   c) Show transparency "Characteristics of Various Soil Classes" and discuss to bring out practicality of soil texture and structure study.
   d) Show the transparencies "Bulk Density" and "Particle Density" and discuss the illustrated calculations.

4. Summarize and evaluate the lesson.

Objectives:

1. Students be able to determine the texture, and structural types of the soil.

2. Students should be able to list the structural classes of the soil and where they are found in the profile.

3. Students should understand and be able to discuss the influences soil texture and structure have on the physical features of the soil.

4. Students should be able to calculate bulk and particle density.

Introduction:

Quite often during a droughty summer some places in a field the crop will "fire" before another. Why is this?

References:

Text: Selected reference

Film Strips: "Soil Texture" V. A. S., Illinois
"Soil Color", V. A. S., Illinois
"Soil Structure", V. A. S., Illinois

Bulletins: "Soil Texture", V. A. S. 4030, Illinois
"Soil Color", V. A. S. 4029, Illinois
"Soil Structure", V. A. S. 4028, Illinois

Problems:

1. What are the physical features of the soil?
2. How is soil texture defined?
3. What are the soil textural classes?
4. What is soil structure? What causes it?
5. What are the soil structural types and where are they found in the soil profile?
6. What are the physical characteristics of a sandy soil? a silty soil? a clay soil?
7. What is bulk and particle density?

Summary:

Soil is composed primarily of sand, silt, clay, and organic matter in varying proportions. These proportions determine many characteristics about how well a soil will produce vegetation.

Evaluation:

A. Did the students learn how to determine the relative proportions of the soil separates in a sample?

B. Did the students learn how to recognize the various soil structural classes?

C. Can the students discuss the characteristics of a soil in terms of its texture?

Student evaluation:

H

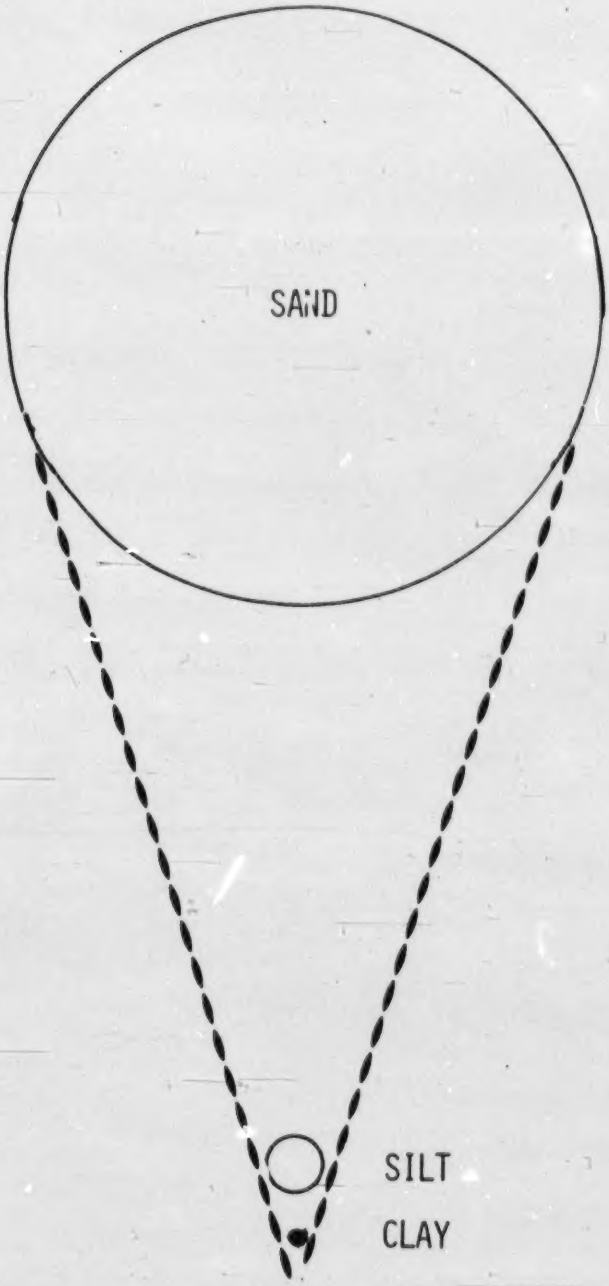
SOIL TEXTURE:

-FINENESS OR COURSENESS OF THE MINERAL PARTICLES
-RELATIVE PROPORTIONS OF SAND, SILT, AND CLAY
-ALSO CALLED SOIL SEPARATES
-PERCENT OF SAND, SILT, AND CLAY IN THE SOIL

MAJOR TEXTURAL CLASSES

1. SAND
2. LOAMY SAND
3. SANDY LOAM
4. SANDY CLAY LOAM
5. SANDY CLAY
6. LOAM
7. CLAY LOAM
8. SILT LOAM
9. SILT
10. SILTY CLAY LOAM
11. SILTY CLAY
12. CLAY

RELATIVE SIZES OF SAND
SILT AND CLAY



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DEMONSTRATION OF TEXTURE DETERMINATION (BOUYOUCOS METHOD)

MATERIAL		PRICE NASCO
Mortis and Pestle (rubber)		$10.00
2 mm. Seive	(set)	$60.00
Distilled Water		---
Calgon		---
Malt-making machine with baffled cups		---
Bouyoucos Cylinder		$ 6.50
Bouyoucos Hydrometer		$12.70
Fahrenheit Thermometer		$ 2.50
Watch with se cond hand		---

PROCEDURE -

1. Grind the soil with a rubber pestle and pass through a 2 mm. seive.
2. Place 50.0 gms. of soil in baffled-malt cup and add distilled water to within 2-3 inches from the top.
3. Add 5 gms. Calgon.
4. Connect cup to stirring motor and stir for 5 minutes.
5. Pour and wash the suspension into special cylinder.
6. Fill with distilled water to the lower mark with the hydrometer in it.
7. Remove hydrometer.
8. Place hand over mouth of cylinder and shake vigorously, turning cylinder upside down and back several times.
9. Place cylinder on table and note time immediately.
10. Replace hydrometer, and record reading of hydrometer and the temperature of the suspension at the end of 40 seconds.
11. Carefully remove hydrometer.
12. At end of two hours replace hydrometer and record hydrometer reading and the temperature.

H

Since the hydrometer is calibrated at 67° F, apply a temperature correction of 0.2 graduation on the hydrometer for every 1° F above or below 67° F. Add the correction if the temperature is above 67° and subtract if below.

To calculate the conventional amount of combined sand (1.0-0.5 mm.), silt (0.05-0.002 mm.), and clay (0.002 mm. and less), as described by this method, the following procedure is used.

The corrected hydrometer reading at the end of 40 seconds is divided by the amount of soil taken (50 gms.) and multiplied by 100. The result is the amount of material still in suspension at the end of 40 seconds. This percentage is subtracted from 100% and the result is the percentage of material that has settled out in 40 seconds, or the percentage of sand.

The corrected hydrometer reading at the end of the two hours is divided by the amount of soil sample (50 gms.) and multiplied by 100. This result is the percentage of conventional clay.

The percentage of silt is obtained by subtracting the sum of the percentage of sand and clay from 100%.

Textural grade can then be determined from textural triangle.

TABULATE YOUR RESULTS AS FOLLOWS

	Reading	Temperature F°	Corrected Reading	Percentage
SAND 40 sec.				
CLAY 2 hours				
SILT By Difference				

TEXTURAL CLASS: _____

Alternate Method for Textural Determination

Materials needed:

1. One or more 150-200 cc's graduated burettes or a tall jar of small diameter
2. Soil sample(s)
3. Beaker of water
4. Ruler

Procedure:

1. Obtain soil sample
2. Pulverize the sample
3. Measure 100 cc's into the burette
4. Add water to the 150 cc burette to flood the sample
5. Stopper and shake vigorously
6. Allow sample to settle overnight
7. Calculate the depth of the layers of sand, silt, and clay
8. Measure by ruler or cc graduations
9. Determine percentages by dividing total depth into depth of each layer

Observation sheet:

Date_____ Name_____

A. Amount of soil measured in burette or jar_____.
B. Amount of sand measured in burette or jar_____.
C. Amount of silt measured in burette or jar_____.
D. Amount of clay measured in burette or jar_____.

Alternate method (continued)

Percentage of sand:

B ÷ A = _____ ÷ _____ = _____% sand

Percentage of silt:

C ÷ A = _____ ÷ _____ = _____% silt

Percentage of clay:

D ÷ A = _____ ÷ _____ = _____% clay

This sample, according to the textural triangle, belongs in the _____ textural class.

Procedure for determining textural class by the "feel" method:

a. Make a stift mud ball.
b. Rub the mud ball between the thumb and forefinger.
c. Note the degree of coarseness and grittiness due to the sand particles.
d. Squeeze the mud between the fingers and then pull your thumb and fingers apart. Note the degree of stickiness due to the clay particles.
e. Make the soil slightly more moist and note that the clay leaves a "slick" surface on the thumb and fingers.

The outstanding physical characteristics of the important textural grades, as determined by the "feel" of the soil, are:

Sandy soil - Loose and single grained. The individual grains can be seen readily or felt. Squeezed in the hand when dry, it will fall apart when the pressure is released. Squeezed when moist, it will form a cast, but will crumble when touched.

Sandy loam soil - Contains much sand but has enough silt and clay to make it somewhat sticky. Individual sand grains can be seen readily and felt. Squeezed when dry, it will form a cast which will readily fall apart, but if squeezed when moist, a cast can be formed which will bear careful handling without falling apart.

Loam soil - Has a relatively even mixture of the sands, silt, and clay. Actually, however, the clay content is less then 20%. (The characteristic properties of clay are more pronounced than those of sand.) A loam is mellow with a somewhat gritty feel yet fairly smooth and highly plastic. Squeezed when moist, it will form a cast which can be handled quite freely without breaking.

Silt loam soil - When dry, may appear quite cloddy but lumps are readily broken, and when pulverized it feels soft and floury. When wet, the soil readily runs together. Either dry or moist, it will form casts which can be handled freely without breaking, but when moistened and squeezed between the thumb and fingers, it will not "ribbon" but will give a broken appearance.

Clay loam soil - Fine-textured soil which usually breaks into clods or lumps that are hard when dry. When moist soil is pinched between thumb and fingers, it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand, it does not crumble readily but tends to work into a heavy compact mass.

Clay soil - Fine-textured soil that usually forms very hard lumps or clods when dry and is quite plastic. It is usually very sticky when wet. When the moist soil is pinched between the thumb and fingers it will form a long, flexible "ribbon." A clay soil leaves a "slick" surface on the thumb and fingers when rubbed together with a long stroke and a firm pressure. The clay tends to hold the thumb and fingers together due to the stickiness of the clay.

SIZE OF SOIL PARTICLES

NAME	SIZE, DIAMETER IN MILLIMETERS
FINE GRAVEL	2 - 1
COARSE SAND	1.00 - 0.50
MEDIUM SAND	0.50 - 0.25
FINE SAND	0.25 - 0.10
VERY FINE SAND	0.10 - 0.05
SILT	0.05 - 0.002
CLAY	LESS THAN 0.002

SIZE OF SOIL PARTICLES

Size limits of soil separates are established by the U. S. Dept. of Agriculture, Corps of Engineers, and other agencies. These size limits will vary slightly but are still of the same relative ranges. The soil particles, which resulted from glacial action and from weathering, vary greatly in size. They are classified on the basis of size into gravel, sand, silt, and clay. Gravel may range from pebbles down to particles about 1/12 inch in diameter. Sand grains feel gritty and can be easily seen. Silt looks and feels like flour and clay particles are so small that you cannot see them with your unaided eye.

As a rule, both gravelly and sandy soils drain readily and work easily. If soils contain too much sand or gravel, however, the water drains away too fast and plants suffer from drouth during a dry spell. In soils of this kind, organic matter decays rapidly after it is plowed down. The plant food which is released, particularly the nitrogen, leaches out readily and is carried away in the soil drainage water.

Since silt is much finer than sand, soils made up largely of this material retain moisture well. At the same time they are open enough that air and water move freely through them. These soils usually work well.

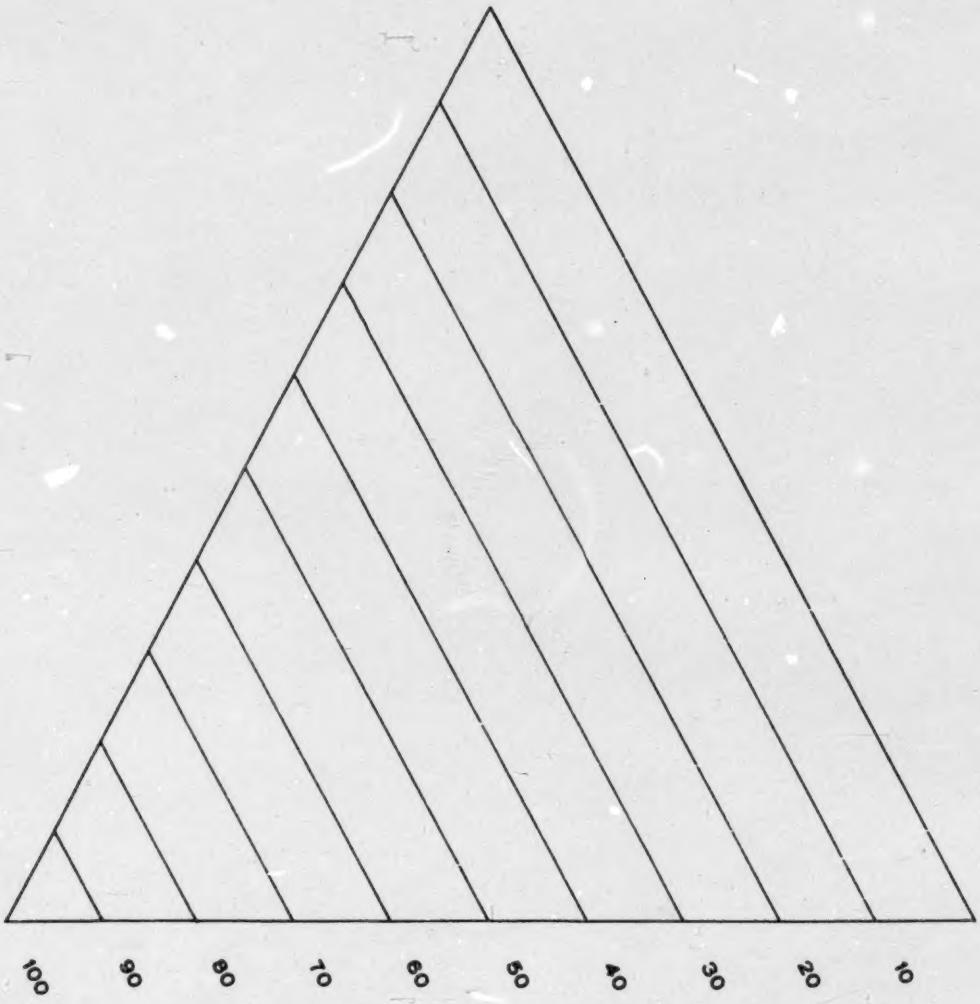
The very fine particles in clay soils help to hold water in the soil and also serve as a storehouse for minerals upon which plant roots can draw. Too much clay, however, makes the soil slow to drain and hard to work.

VOCATIONAL AGRICULTURE SERVICE
434 MUMFORD HALL
URBANA, ILLINOIS
61801

SIZES OF SOIL SEPARATES

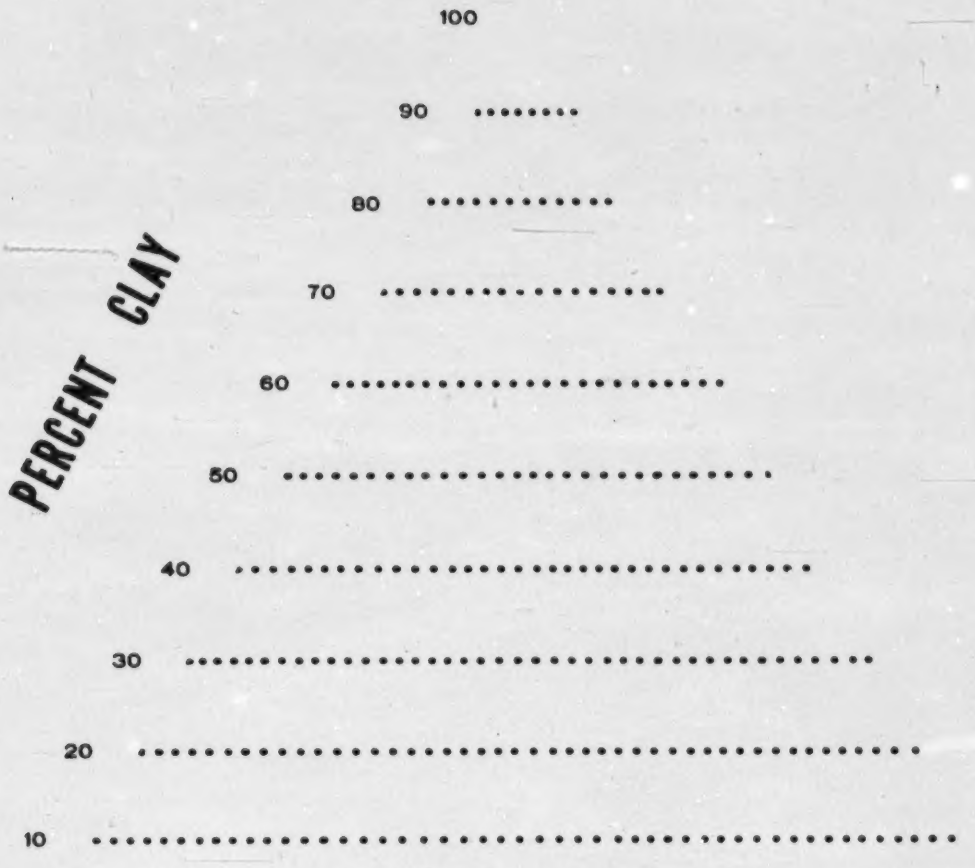
PARTICLE	DIAMETER (MM.)
BOULDERS	256
COBBLES	256-64
PEBBLES	64-4
GRAVEL	4-2
FINE GRAVEL	2-1
COARSE SAND	1-0.5
MEDIUM SAND	0.5-.25
FINE SAND	.25 - .1
VERY FINE SAND	.1 - .05
SILT	.05 - .002
CLAY	.002 - AND LESS

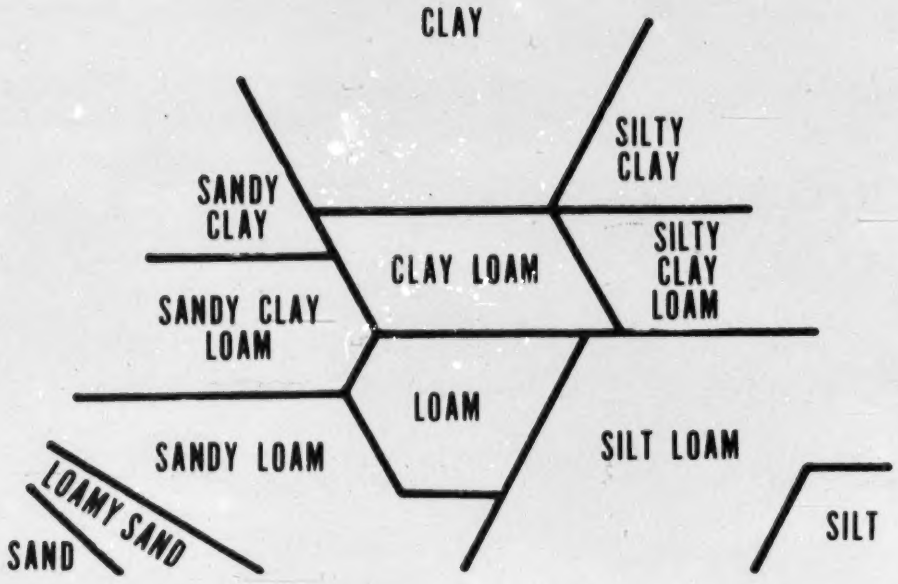
SOIL TEXTURAL CLASSIFICATION TRIANGLE



PERCENT SAND

PERCENT SILT
10
20
30
40
50
60
70
80
90
100


PERCENT CLAY
100
90
80
70
60
50
40
30
20
10


CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SANDY LOAM
SILT LOAM
LOAMY SAND
SAND
SILT

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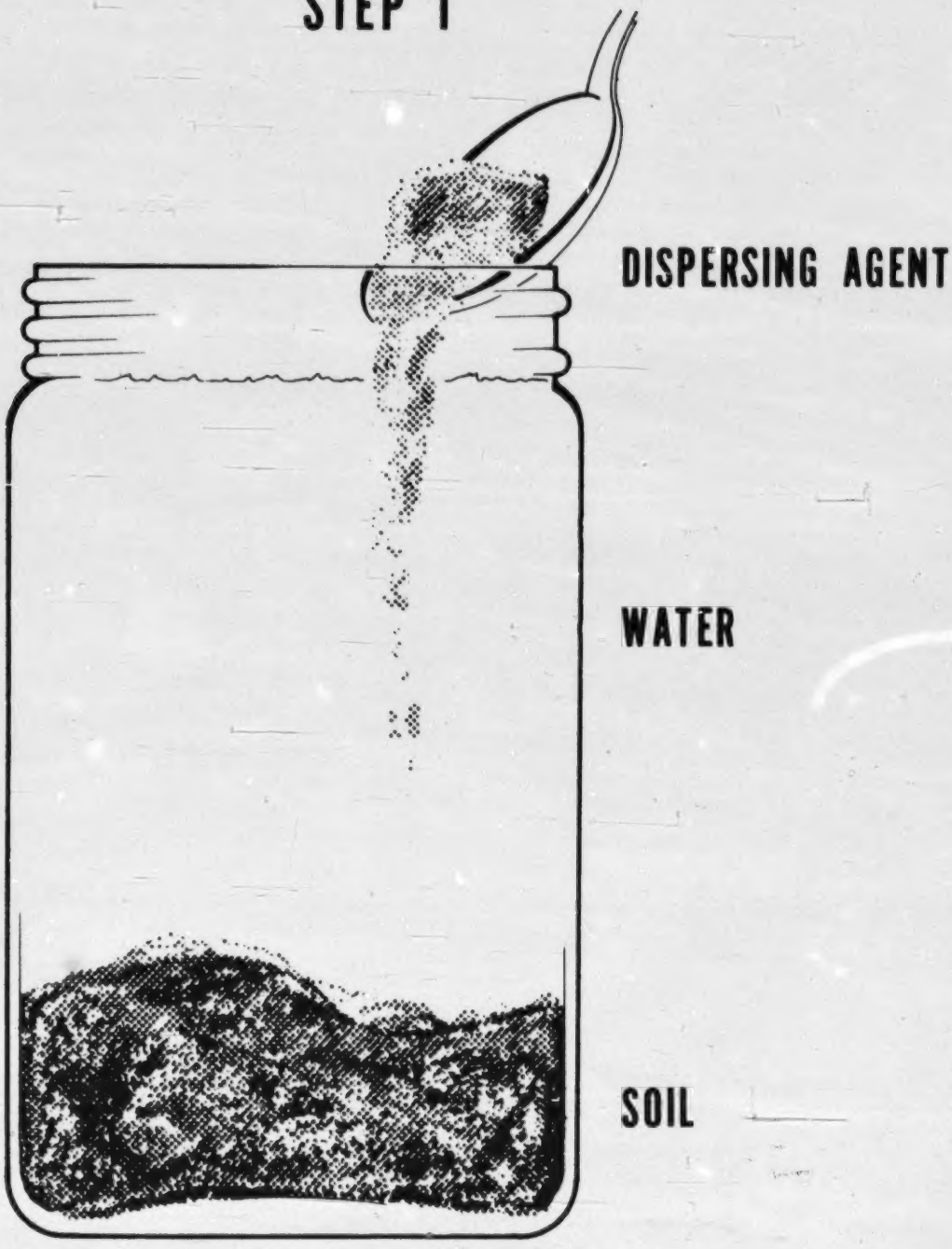
DEMONSTRATION TO SHOW SAND, SILT, AND CLAY

MATERIAL - A quart jar with lid.
1/2 teaspoon of Calgon
A handfull of medium - textured soil

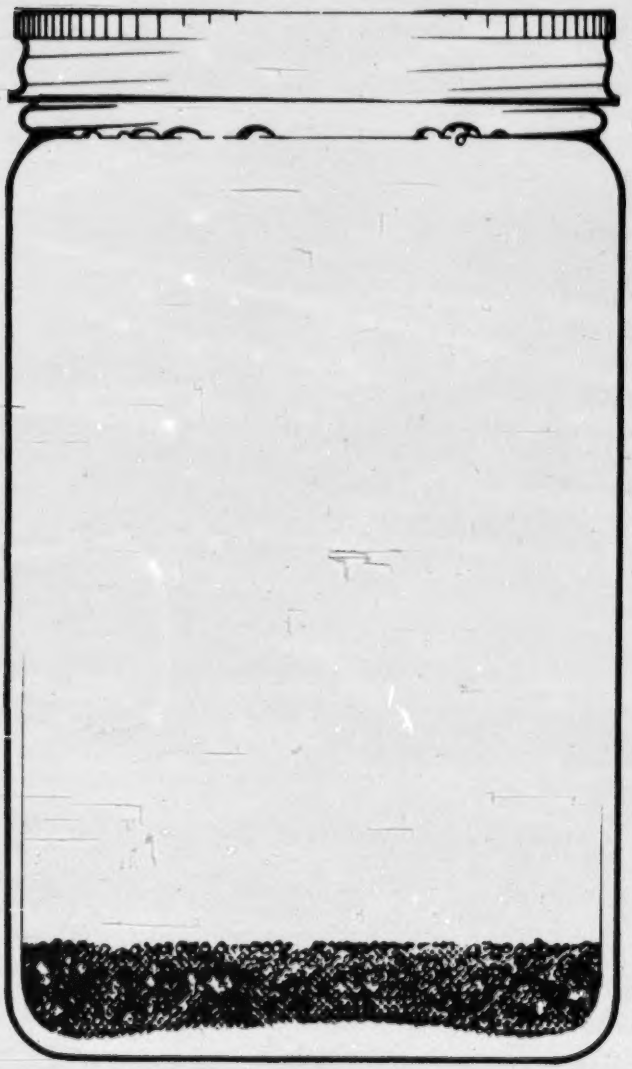
PROCEDURE - Fill the jar half-full of soil.
Add enough water to make the jar 3/4 full.
Add 1/2 teaspoon of Calgon.
Shake for 5 minutes.
Set jar aside and allow to settle undisturbed.
Note the soil separates settling into layers.

MECHANICAL ANALYSIS OF SOILS
STEP I

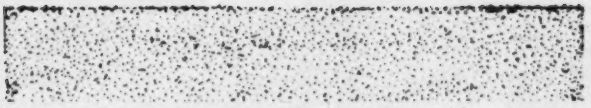


MECHANICAL ANALYSIS OF SOILS
STEP II

(24 HOURS AFTER SHAKING)



SILT



CLAY

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SOIL TEXTURAL CLASSES

SAND — DRY: LOOSE AND SINGLE GRAINED; FEELS GRITTY. MOIST: WILL FORM VERY EASILY-CRUMBLED BALL. SAND--85-100%, SILT--0-15%, CLAY--0-10%.

LOAMY SAND — DRY: SILT AND CLAY MAY MASK SAND; FEELS LOOSE, GRITTY. MOIST: FEELS GRITTY; FORMS EASILY-CRUMBLED BALL; STAINS FINGERS SLIGHTLY. SAND--70-90%, SILT--0-30%, CLAY--0-15%.

SANDY LOAM —DRY: CLODS EASILY BROKEN; SAND CAN BE SEEN AND FELT. MOIST: MODERATELY GRITTY; FORMS BALL THAT CAN STAND CAREFUL HANDLING; DEFINITELY STAINS FINGERS. SAND--43-85%, SILT--0-50%, CLAY--0-20%.

LOAM —DRY: CLODS MODERATELY DIFFICULT TO BREAK; MELLOW, SOMEWHAT GRITTY. MOIST: NEITHER VERY GRITTY NOR VERY SMOOTH; FORMS A FIRM BALL; STAINS FINGERS. SAND--23-52%, SILT--28-50%, CLAY--7-27%.

SILT LOAM —DRY: CLODS DIFFICULT TO BREAK; WHEN PULVERIZED FEELS SMOOTH, SOFT AND FLOURY, SHOWS FINGERPRINTS. MOIST: HAS SMOOTH OR SLICK "BUTTERY" OR "VELVETY" FEEL; STAINS FINGERS. SAND--0-50%, SILT--50-88%, CLAY--0-27%.

CLAY LOAM — DRY: CLODS VERY DIFFICULT TO BREAK WITH FINGERS. MOIST: HAS SLIGHTLY GRITTY FEEL; STAINS FINGERS; RIBBONS FAIRLY WELL. SAND--20-45%, SILT-15-53%, CLAY--27-40%.

SILTY CLAY LOAM —SAME AS ABOVE BUT VERY SMOOTH. SAND--0-20%, SILT--40-73%, CLAY--27-40%.

SANDY CLAY LOAM —SAME AS FOR CLAY LOAM. SAND--45-80%, SILT--0-28%. CLAY--20-35%.

CLAY — DRY: CLODS CANNOT BE BROKEN WITH FINGERS WITHOUT EXTREME PRESSURE. MOIST: QUITE PLASTIC AND USUALLY STICKY WHEN WET; STAINS FINGERS. (A SILTY CLAY FEELS SMOOTH, A SANDY CLAY FEELS GRITTY.) SAND--0-45%, SILT--0-40%, CLAY--40-100%.

SOIL TEXTURAL CLASSES

Each of the soil particles has a distinctive feel; with a knowledge of soil textural classes and some experience, students should be able to determine the texture of soil. The best way to estimate texture in the field is to feel the soil with your fingers. The soil should be moist because the clay is more readily estimated. The following procedure is recommended:

Moisten a sample of soil to the consistency of workable putty. From this sample make a ball about 1/2 inch in diameter. Hold the ball between the thumb and index finger. Then gradually press your thumb down and forward, forming the soil into a ribbon.

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ESTIMATING TEXTURE

If a ribbon forms easily when pressed between the thumb and forefinger, and remains long and flexible, the sample is probably clay or silty clay and is considered fine-textured. Soils in this group are very sticky and plastic.

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ESTIMATING TEXTURE

If a ribbon forms but breaks into pieces 3/4 to 1 inch long, it is probably a clay loam or silty clay loam and is moderately fine textured. Soils in this group are moderately sticky and plastic.

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8/29

ESTIMATING TEXTURE

If a ribbon is not formed and the sample breaks into pieces less than 3/4 inch long, it is probably a silt loam, loam, or sandy loam. The sample would, therefore, be in one of two groups — medium textured or moderately coarse-textured. The decision will rest on whether silt or sand predominates in the sample.

If the soil feels smooth and talc-like, with no grittiness, silt predominates then the soil is termed medium-textured. If the soil feels slightly gritty, yet fairly smooth and talc-like, it is probably a loam or silt loam and is also included in the medium-textured group.

A pronounced gritty feel and a lack of smoothness indicates that sand likely predominates. This soil is then considered moderately coarse textured.

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ESTIMATING TEXTURE

If the sample is composed almost entirely of gritty material and leaves little or no stain on the hand, it is a sand and is considered coarse-textured. Soils composed of gravel, with very little fine material will also fall into this classification.

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CHARACTERISTICS OF VARIOUS TEXTURAL CLASSES

CHARACTERISTIC	COURSE	MEDIUM	FINE
LOOSENESS	GOOD	FAIR	POOR
AIR SPACE	GOOD	FAIR TO GOOD	POOR
INFILTRATION RATE	GOOD	FAIR TO GOOD	POOR
PERCOLATION RATE	GOOD	FAIR TO GOOD	POOR
RESISTANCE TO CLOD FORMATION	GOOD	FAIR	GOOD
EASE OF WORKING	GOOD	FAIR	POOR
MOISTURE HOLDING	POOR	FAIR	GOOD
NUTRIENT HOLDING CAPACITY	FAIR	FAIR TO GOOD	GOOD

SOIL STRUCTURE - ARRANGEMENT OF SOIL PARTICLES INTO AGGREGRATES, OR PEDS

CAUSES OF GRANULATION

1. FREEZING AND THAWING
2. WETTING AND DRYING
3. ROOT MOVEMENT
4. EARTHWORMS
5. ORGANIC MATTER AND SLIMES
6. SOIL TILLAGE

TYPES OF SOIL STRUCTURE

TYPE	LOCATION	SIZE
GRANULAR	"A" HORIZON	3-5 MM
PLATY	"A2" HORIZON	
BLOCKY	"B" HORIZON	5-12 MM
SUBANGULAR BLOCKY	"B" HORIZON	
PRISMATIC	"B" HORIZON	
COLUMNAR	"B" HORIZON	7250 MM

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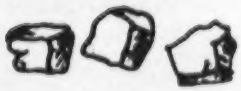
COMMON TYPES OF SOIL STRUCTURE

TYPE	SHAPE
GRANULAR	
CRUMB	
PLATY	
PRISMATIC	
COLUMNAR	
BLOCKY	
SINGLE GRAIN	
MASSIVE	

TRANSPARENCIES - SOI CE 32

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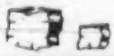
COMMON TYPES OF SOIL STRUCTURE

The term "structure" is used when considering the arrangement of soil particles into various sizes and shapes. This transparency illustrates the principal kinds of structures found in Illinois soils.

Kind of structure	Description of aggregates (clusters)		Horizon
Crumb	Aggregates are small, porous, and weakly held together	Nearly spherical, with many irregular surfaces	Usually found in surface soil or A horizon
Granular	Aggregates are small, non-porous, and are strongly held together		
Platy	Aggregates are flat or plate-like, with horizontal dimensions greater than the vertical. Plates overlap, usually causing slow permeability		Usually found in subsurface or A_2 horizon of timber and claypan soil
Angular blocky or cube-like 	Aggregates have sides at nearly right angles, tend to overlay	Nearly block-like, with 6 or more sides. All 3 dimensions about the same	Usually found in subsoil or B horizon
Subangular blocky or nut-like	Aggregates have sides forming obtuse angles, corners are rounded. Usually more permeable than blocky type		
Prismatic	Without rounded caps	Prism-like with the vertical axis greater than the horizontal	
Columnar	With rounded caps		
Structure lacking Single grain	Soil particles exist as individuals such as sand and do not form aggregates		Usually found in substratum or C horizon
Massive	Soil material clings together in large uniform masses, as in loess		

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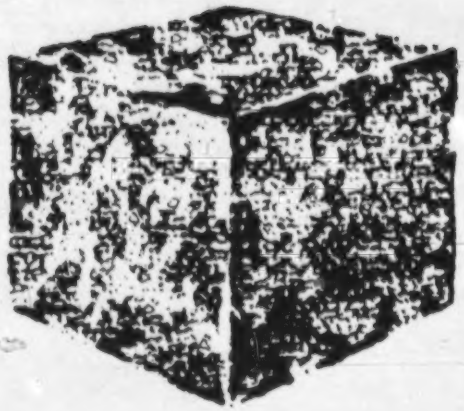
SOIL STRUC

BULK DENSITY



$$\text{BULK DENSITY} = \frac{\text{WEIGHT OF SOIL}}{\text{VOLUME OF SOIL}}$$

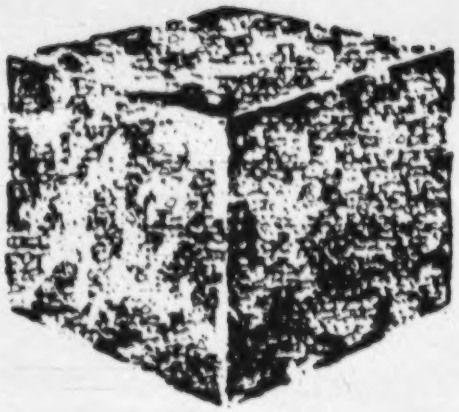
EXAMPLE:

WEIGHT = 2.66 grams

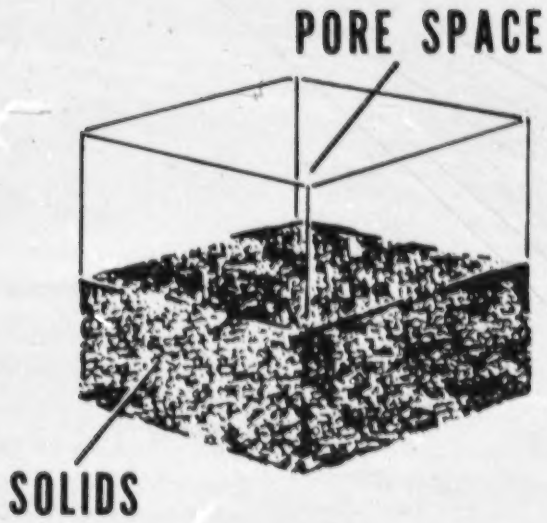
VOLUME = 2 cubic centimeters

$$\frac{2.66\ \text{g}}{2\ \text{cc}} = 1.33\ \text{g/cc} = \text{BULK DENSITY}$$

PARTICLE DENSITY



SOIL MASS
(solids and pore space)



$$\text{PARTICLE DENSITY} = \frac{\text{WEIGHT OF SOIL MASS}}{\text{VOLUME OF SOLIDS ONLY}}$$

EXAMPLE:

WEIGHT OF SOIL MASS = 2.66 grams

VOLUME OF SOLIDS ONLY = 1 cubic centimeter

$$\frac{2.66\ \text{g}}{1\ \text{cc}} = 2.66\ \text{g/cc} = \text{PARTICLE DENSITY}$$